

HISTORY AND REVIEW OF RAILWAY-HIGHWAY GRADE CROSSING WARNING SYSTEMS AND THE GENESIS OF STANDARD SPECIFICATION

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INTRODUCTION

Warning systems at railroad/highway grade crossings occupy a prominent position among the operating functions of a railroad. These systems do not contribute to the services rendered by a railroad—the movement of goods and people—yet large and continuing expenditures of time and money are required each year on the part of the railroads and highway departments for the maintenance, operation, and renewal of the equipment involved. To better understand the rationalization of grade crossing warning systems as we see them today, certain contributing factors must be acknowledged, including a brief history of development.

GRADE CROSSING WARNING SYSTEMS— DEVELOPMENT HISTORY

The first warning means used at grade crossings consisted of conspicuous signs placed at the crossings, one sign generally sufficing for either a single or multiple track crossing. The legends on the signs conformed with the ideas of various railroad officials, state laws, and local authorities. It was also required that the engine whistle be sounded at varying distances from a crossing, one-fourth mile being most favored. The engine bell also was sounded until the train reached the crossing.

At some crossings where vehicular and train traffic was relatively heavy, crossing watchmen were used along with the signs. The watchmen usually flagged the traffic with a red flag during the day and a red lantern during periods of darkness. The warning given by the watch-

men was frequently ignored by the drivers, a practice which not only increased the hazard of crossing the track, but also jeopardized the watchmen as well.

To alleviate this problem, manually operated gates which extended over the roadway were developed and used at some crossings beginning in 1870. These acted as a barrier to approaching vehicles and were first actuated by wire or pipe connections; later they were operated pneumatically, then by electric motors. Appropriate signs were continued in use to denote the existence of the crossing.

In 1889, the first automatic control was used. This was an electrical switch placed under the rail so that the weight of a train would activate a bell at the crossing. The bell at that time was quite satisfactory, as it could be heard by pedestrians and horsedrawn vehicles. The bell is still used as an adjunct to modern crossing warning systems and serves as a good warning for persons outside of automobiles and trucks.

The first application of an automatically controlled visual signal was introduced in 1914 in the form of a wigwag, which was a means of duplicating the watchman waving his lantern. There are a number of these wigwags still in use today, but they are being replaced with flashing light signals as crossings are upgraded.

In 1912, the wavelight signal was first used, and here again the watchman waving his lantern idea was perpetuated without moving parts. Although improvements have been made in flashing light signals, their appearance has remained about the same and they are the standard we accept today.

Coincident with the changes in the indicating devices, the detection of trains was improved by incorporation of the DC track circuit in 1914. The track circuit is a positive means of detecting the presence of a train in the approach section to the crossing. In addition, should a failure occur in the track circuit because of a broken wire, poor connection, short-circuit, or broken rail, the crossing warning equipment would be activated.

In 1936, automatic gates were first used as an addition to the flashing light signals and bells. The gates were designed on the normally energized principle, in that they were held up electrically. When power was removed for any reason, they dropped by gravity. The arms were first referred to as "short arms" and were only long enough to block one approaching lane of traffic. Today, arms are provided up to 45 ft. in length and are made of wood, fiberglass, or aluminum.

About the same time that gates were first used, perhaps a little earlier, the steel cantilever structure came into being to relocate the

flashing lights to a position over the highway where they could be seen more readily. The first cantilevers used arms of 6 to 8 ft. in length, which were extended to 12 ft. in the early 1940's. In the late 1950's the aluminum cantilever structure of the rotatable type was introduced. Today, both rotatable arms up to 26 ft. long and walkout structures up to 40 ft. long are available. Lane lights, back-to-back flashers, and crossbucks are used where needed on cantilever arms.

By 1950, it had been shown that the DC track circuits used to detect trains on the approaches to grade crossings could be replaced by audio frequency overlay (AFO) track circuits. AFO track circuits did not require the use of insulated joints to define the limits of the circuit and did not interfere with DC track circuits used in railroad block signaling systems. Various AFO track circuits adjacent to each other were kept from interfering, one with another, by using different transmitting frequencies. The use of AFO track circuits for crossing warning systems has become widespread and now accounts for much of the grade crossing train detection equipment being installed today.

By 1960, it was recognized by the Southern Pacific Railroad that a train detection system was needed that was related to the speed, distance, and direction of trains. As a result, control equipment was developed that predicted the time of arrival of a train at a crossing and provided the same warning time for all trains regardless of their speed. This equipment is currently in use on all major railroads. Motion sensing devices are also used extensively. These activate the crossing warning equipment whenever a train is moving *toward* or actually occupies the crossing.

A comment should be offered concerning the design of electronic equipment used in crossing warning systems. This equipment follows the same safe design principles for operation and reliability as the original DC track circuit. To accomplish this, however, it has been said that 10% of the design effort is in making the equipment work and 90% in assuring proper operation and reliability. The railroad environment, both because of natural causes and vandalism, is acknowledged to be one of the most difficult in which to install equipment and provide the reliable operation required.

AAR AND UNIFORM STANDARDS FOR CROSSING WARNING SYSTEMS

It might be well now to briefly review the history of the organization which is now known as the Association of American Rail-

roads (AAR). All Class I railroads in North America belong to the AAR, which is headquartered in Washington, D.C., and speaks for and supports the railroads in their efforts to obtain needed legislation. It serves to knit together the various interests of railroads toward a common goal. We will speak particularly about that part of the AAR known as the Communication and Signal Section, whose jurisdiction includes railroad signaling and grade crossing warning systems.

In 1916, the American Railway Association, predecessor of the AAR, formulated and adopted certain uniform standards for crossing warning systems. These standards included the painting of crossing gates with black and white stripes and provided for the installation of standard approach signs at a given distance from grade crossings, the display of red lights on crossing gates, and specified the type of warning given by a watchman.

As the number of vehicles on the highway and their area of operation continued to increase, it became desirable to promote acceptance of uniformity in crossing warning systems in the various states to eliminate or reduce elements which tended to confuse the motorist.

Committee D—Signal and Communication Section, AAR

In April 1930, a joint Committee on Railroad/Highway Grade Crossings was organized within the American Railway Association. The joint committee was very successful in accomplishing its mission. It was succeeded by a permanent technical standing committee known as the Grade Crossing Protection Subcommittee of the Train Operation, Control, and Signals Committee of the AAR. This subcommittee was later to be renamed—Committee D of the Signal and Communication Section of the AAR, which is its present designation. The membership of Committee D consists of railroad signal engineers, representatives from state highway departments, the U.S. Department of Transportation (DOT) and consultants from the railroad signal supply industry.

Uniform Equipment and Installation Standards

Over the years, Committee D and its predecessor committees have established uniform equipment and installation standards which have served to standardize all of the equipment used at highway crossings. The specifications for this equipment are such that only equipment of the highest quality, capable of reliable and trouble-free service for many years can be employed. The reasons for the high standards are very simple—this equipment is a vital part of railroad and highway safety—human lives are involved. If it fails to perform its job, even under the most adverse environmental conditions, lives could be lost. In

addition, because railroads are spread out all over the country, their ability to service and maintain this equipment at remote locations is severely handicapped. When an installation is made, it is expected to perform as intended for many, many years with an absolute minimum of maintenance. Such can only be the case with equipment built to take heavy use.

Signal Manual and Specifications

The AAR specifications governing this equipment by and large have been written over a long period of time based on practical operating experience. One of the key assignments of Committee D is to continually keep these specifications, or signal manual parts, as they are called, up-to-date—reflecting current practice. At the present time there are 13 parts of the signal manual devoted to the specifications and requisites for grade crossing warning systems and devices. These are:

- MP 21—Highway Crossing Bell
- MP 74—Requisites for Track Circuit Type Motion Sensitive Systems for Approach Control of Highway Crossings
- MP 148—Requisites for Highway Grade Crossing Signals and Devices
- MP 149—Automatic Highway Grade Crossing Signals and Devices—Installation of Systems
- MP 150—Automatic Highway Grade Crossing Protective Systems—Maintenance and Test Instructions
- MP 151—Interconnection of Street Traffic Signals with Highway Grade Crossing Signals and Devices
- MP 152—Nontrack Circuit Type Motion Sensitive Systems for Approach Control of Highway Grade Crossing Signals
- MP 166—Specification for Electric Light Unit for Highway Grade Crossing Signal
- MP 194—Specification for Gate Mechanism
- MP 263—Specification for Gate Arm Electric Light Units
- MP 268—Instructions for Aligning Highway Crossing Signal Reflector Type Light Units
- MP 274—Requisite for Control of Automatic Highway Grade Crossing Signals and Devices
- MP 276—Specification for Reflex-Reflecting Sheet Material

In addition to the signal manual, the AAR also publishes a bulletin entitled “Railroad-Highway Grade Crossing Warning Systems—Recommended Practices.” This bulletin is updated by the AAR every few

years after agreement has been reached by all interested organizations. At the present time, the seventh edition of this bulletin is in use. Bulletin No. 7 serves as a guide to the states in connection with the current highway grade crossing safety program which is funded under the Federal-Aid Highway Acts of 1973 and 1976.

AAR Bulletin—RR-Highway Grade Crossing Warning Systems—Recommended Practice

In conclusion, this has been a rather rapid review of over a century of progress in the evolution of grade crossing warning systems, and the specifications governing such systems. These systems and the techniques for their application are now readily available. In states where there has been very close cooperation between the railroads and state highway departments in the implementation of programs under sections 203 and 230 of the Federal-Aid Highway Act of 1973, there has been a dramatic reduction in deaths at highway crossings. In Georgia for instance, there were 105 fatal highway crossing accidents during 1974. These were reduced to 58 in 1975. There is every reason to believe that similar progress could be made countrywide with an all-out effort by all parties concerned. We hope very much that this information will be of help to you with your program.